

## Vog Size Distributions, Optical Effects, and Spatial Variability

Vog is primarily a sulfate aerosol with a significant amount of associated water that varies with ambient relative humidity. It is usually mixed into the background aerosol and has a submicrometer size distribution with a mass peak near  $0.35\text{ }\mu\text{m}$ . This size is particularly effective for scattering visible light, making light scattering measurements a rapid and reasonable surrogate for inferring the mass concentration of the vog aerosol. Light scattering measurements made every few seconds reveal marked variability in the vog structure over both horizontal and vertical scales. Factor of 10 changes in concentration were observed over time periods of less than one hour at the coastal site of Cape Kumukahi on the Big Island. Measurements from light aircraft reveal vertical gradients that can also increase by a factor of 10 between the surface and the trade-wind inversion. Under appropriate meteorological conditions, these high concentrations aloft also can mix down to the surface. Temperature changes during the day vary relative humidity in ways that can result in changes in visibility for the same sulfate concentration. These factors must be considered when designing a sampling strategy or interpreting the results. In relation to potential health effects, during normal inhalation the hygroscopic growth of this vog aerosol will grow in response to the near 100% humidity in the airways. Deposition determinations suggests that about one-third of the observed vog aerosol will be retained in the airways and lungs.

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## Volcanic Emissions from Kilauea and Their Effect on Air Quality

Kilauea Volcano currently releases between 350 metric tonnes per day (T/D) of sulfur dioxide ( $\text{SO}_2$ ) during eruptive pauses, and 1850 T/D during active eruption. Metric tonnes equal one metric ton or 1000 kilograms. Of this, between 90 T/D and 260 T/D are emitted from the summit and the balance from the East Rift Zone eruptive area. The volcano also directly releases water vapor, small particles, metals, and lesser amounts of other gases, including hydrogen sulfide, hydrogen chloride, hydrogen fluoride. This gas and particle mixture combines with air and sunlight to produce the hazy atmospheric condition known as vog: a combination of gases, sulfate aerosols including among others, sulfuric acid, ammonium sulfate, and ammonium hydrogen sulfate. Gas release of another form occurs at locations where lava enters the ocean. Molten lava ( $110^\circ\text{C}$ ) violently boils sea water to dryness and decomposes it, leading to a series of chemical reactions that produce a voluminous plume cloud containing a mixture of hydrochloric acid and concentrated

seawater. This condition produces a localized atmospheric hazard known as lava haze or laze which can contain as much as 10 to 15 parts per million of hydrochloric acid. The geographic fate of this pollution is primarily a function of meteorology, especially wind speed and wind direction. Typically, northeasterly trade winds transport vog and to some extent laze plumes to the southern tip of the island where wind patterns wrap around, sending vog up the Kona coast. Here, vog becomes trapped by onshore/offshore winds, affecting populations in west Hawaii. During periods of Kona winds, primarily winter months, the eastern half of the island receives more of the vog.

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